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(57) Abstract

The present invention provides systems and methods for electronic commerce including secure transaction management and electronic rights protection. Electronic appliances such as computers employed in accordance with the present invention help to ensure that information is accessed and used only in authorized ways, and maintain the integrity, availability, and/or confidentiality of the information. Secure subsystems used with such electronic appliances provide a distributed virtual distribution environment (VDE) that may enforce a secure chain of handling and control, for example, to control and/or meter or otherwise monitor use of electronically stored or disseminated information. Such a virtual distribution environment may be used to protect rights of various participants in electronic commerce and other electronic or electronic-facilitated transactions. Secure distributed and other operating system environments and architectures, employing, for example, secure semiconductor processing arrangements that may establish secure, protected environments at each node. These techniques may be used to support an end-to-end electronic information distribution capability that may be used, for example, utilizing the "electronic highway".

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methods, load modules, and/or user data elements. This private body (method) section 806 is preferably encrypted using one or more private body keys contained in the separate permissions record 808. The data blocks 812 contain content (information or administrative) that may be encrypted using one or more content keys also provided in permissions record 808.

2. Traveling Objects

Figure 19 shows an example of a "traveling object" structure 860 provided by the preferred embodiment. Traveling objects are objects that carry with them sufficient information to enable at least some use of at least a portion of their content when they arrive at a VDE node.

Traveling object structure 860 may be the same as stationary object structure 850 shown in Figure 18 except that the traveling object structure includes a permissions record (PERC) 808 within private header 804. The inclusion of PERC 808 within traveling object structure 860 permits the traveling object to be used at any VDE electronic appliance/participant 600 (in accordance with the methods 1000 and the contained PERC 808).

"Traveling" objects are a class of VDE objects 300 that can specifically support "out of channel" distribution. Therefore, they include key block(s) 810 and are transportable from one electronic appliance 600 to another. Traveling objects may come with a quite limited usage related budget so that a user may use, in whole or part, content (such as a computer program, game, or database) and evaluate whether to acquire a license or further license or purchase object content. Alternatively, traveling object PERCs 808 may contain or reference budget records with, for example:

(a) budget(s) reflecting previously purchased rights or credit for future licensing or purchasing and enabling at least one or more types of object content usage, and/or

(b) budget(s) that employ (and may debit) available credit(s) stored on and managed by the local VDE node in order to enable object content use, and/or

(c) budget(s) reflecting one or more maximum usage criteria before a report to a local VDE node (and, optionally, also a report to a clearinghouse) is

required and which may be followed by a reset allowing further usage, and/or modification of one or more of the original one or more budget(s).

As with standard VDE objects 300, a user may be required to contact a clearinghouse service to acquire additional budgets if the user wishes to continue to use the traveling object after the exhaustion of an available budget(s) or if the traveling object (or a copy thereof) is moved to a different electronic appliance and the new appliance does not have a available credit budget(s) that corresponds to the requirements stipulated by permissions record 808.

For example, a traveling object PERC 808 may include a reference to a required budget VDE 1200 or budget options that may be found and/or are expected to be available. For example, the budget VDE may reference a consumer's VISA, MC, AMEX, or other "generic" budget that may be object independent and may be applied towards the use of a certain or classes of traveling object content (for example any movie object from a class of traveling objects that might be Blockbuster Video rentals). The budget VDE itself may stipulate one or more classes of objects it

may be used with, while an object may specifically reference a certain one or more generic budgets. Under such circumstances, VDE providers will typically make information available in such a manner as to allow correct referencing and to enable billing handling and resulting payments.

Traveling objects can be used at a receiving VDE node electronic appliance 600 so long as either the appliance carries the correct budget or budget type (e.g. sufficient credit available from a clearinghouse such as a VISA budget) either in general or for specific one or more users or user classes, or so long as the traveling object itself carries with it sufficient budget allowance or an appropriate authorization (e.g., a stipulation that the traveling object may be used on certain one or more installations or installation classes or users or user classes where classes correspond to a specific subset of installations or users who are represented by a predefined class identifiers stored in a secure database 610). After receiving a traveling object, if the user (and/or installation) doesn't have the appropriate budget(s) and/or authorizations, then the user could be informed by the electronic appliance 600 (using information stored in the traveling object) as to which one or more parties the user could

contact. The party or parties might constitute a list of alternative clearinghouse providers for the traveling object from which the user selects his desired contact).

As mentioned above, traveling objects enable objects 300 to be distributed "Out-Of-Channel;" that is, the object may be distributed by an unauthorized or not explicitly authorized individual to another individual. "Out of channel" includes paths of distribution that allow, for example, a user to directly redistribute an object to another individual. For example, an object provider might allow users to redistribute copies of an object to their friends and associates (for example by physical delivery of storage media or by delivery over a computer network) such that if a friend or associate satisfies any certain criteria required for use of said object, he may do so.

For example, if a software program was distributed as a traveling object, a user of the program who wished to supply it or a usable copy of it to a friend would normally be free to do so. Traveling Objects have great potential commercial significance, since useful content could be primarily distributed by users and through bulletin boards, which would require little or no

distribution overhead apart from registration with the "original" content provider and/or clearinghouse.

The "out of channel" distribution may also allow the provider to receive payment for usage and/or elsewise maintain at least a degree of control over the redistributed object. Such certain criteria might involve, for example, the registered presence at a user's VDE node of an authorized third party financial relationship, such as a credit card, along with sufficient available credit for said usage.

Thus, if the user had a VDE node, the user might be able to use the traveling object if he had an appropriate, available budget available on his VDE node (and if necessary, allocated to him), and/or if he or his VDE node belonged to a specially authorized group of users or installations and/or if the traveling object carried its own budget(s).

Since the content of the traveling object is encrypted, it can be used only under authorized circumstances unless the traveling object private header key used with the object is broken—a potentially easier task with a traveling object as compared to, for

example, permissions and/or budget information since many objects may share the same key, giving a cryptoanalyst both more information in cyphertext to analyze and a greater incentive to perform cryptoanalysis.

In the case of a "traveling object," content owners may distribute information with some or all of the key blocks 810 included in the object 300 in which the content is encapsulated. Putting keys in distributed objects 300 increases the exposure to attempts to defeat security mechanisms by breaking or cryptoanalyzing the encryption algorithm with which the private header is protected (e.g., by determining the key for the header's encryption). This breaking of security would normally require considerable skill and time, but if broken, the algorithm and key could be published so as to allow large numbers of individuals who possess objects that are protected with the same key(s) and algorithm(s) to illegally use protected information. As a result, placing keys in distributed objects 300 may be limited to content that is either "time sensitive" (has reduced value after the passage of a certain period of time), or which is somewhat limited in value, or where the commercial value of placing keys in objects (for example convenience to end-users, lower cost of eliminating

the telecommunication or other means for delivering keys and/or permissions information and/or the ability to supporting objects going "out-of-channel") exceeds the cost of vulnerability to sophisticated hackers. As mentioned elsewhere, the security of keys may be improved by employing convolution techniques to avoid storing "true" keys in a traveling object, although in most cases using a shared secret provided to most or all VDE nodes by a VDE administrator as an input rather than site ID and/or time in order to allow objects to remain independent of these values.

As shown in Figure 19 and discussed above, a traveling object contains a permissions record 808 that preferably provides at least some budget (one, the other, or both, in a general case). Permission records 808 can, as discussed above, contain a key block(s) 810 storing important key information. PERC 808 may also contain or refer to budgets containing potentially valuable quantities/values. Such budgets may be stored within a traveling object itself, or they may be delivered separately and protected by highly secure communications keys and administrative object keys and management database techniques.

The methods 1000 contained by a traveling object will typically include an installation procedure for "self registering" the object using the permission records 808 in the object (e.g., a REGISTER method). This may be especially useful for objects that have time limited value, objects (or properties) for which the end user is either not charged or is charged only a nominal fee (e.g., objects for which advertisers and/or information publishers are charged based on the number of end users who actually access published information), and objects that require widely available budgets and may particularly benefit from out-of-channel distribution (e.g., credit card derived budgets for objects containing properties such as movies, software programs, games, etc.). Such traveling objects may be supplied with or without contained budget UDEs.

One use of traveling objects is the publishing of software, where the contained permission record(s) may allow potential customers to use the software in a demonstration mode, and possibly to use the full program features for a limited time before having to pay a license fee, or before having to pay more than an initial trial fee. For example, using a time based billing method and budget records with a small pre-installed time budget to

allow full use of the program for a short period of time. Various control methods may be used to avoid misuse of object contents. For example, by setting the minimum registration interval for the traveling object to an appropriately large period of time (e.g., a month, or six months or a year), users are prevented from re-using the budget records in the same traveling object.

Another method for controlling the use of traveling objects is to include time-aged keys in the permission records that are incorporated in the traveling object. This is useful generally for traveling objects to ensure that they will not be used beyond a certain date without re-registration, and is particularly useful for traveling objects that are electronically distributed by broadcast, network, or telecommunications (including both one and two way cable), since the date and time of delivery of such traveling objects aging keys can be set to accurately correspond to the time the user came into possession of the object.

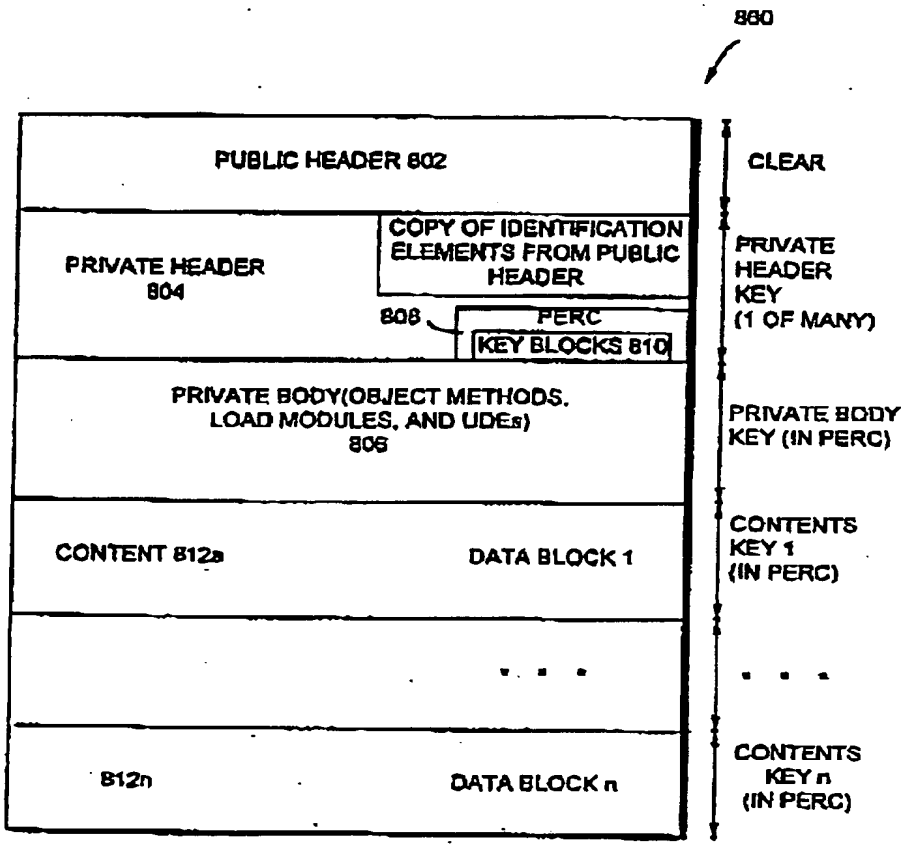
Traveling objects can also be used to facilitate "moving" an object from one electronic appliance 600 to another. A user could move a traveling object, with its incorporated one or more permission records 808 from a desktop computer, for example, to

his notebook computer. A traveling object might register its user within itself and thereafter only be useable by that one user. A traveling object might maintain separate budget information, one for the basic distribution budget record, and another for the "active" distribution budget record of the registered user. In this way, the object could be copied and passed to another potential user, and then could be a portable object for that user.

Traveling objects can come in a container which contains other objects. For example, a traveling object container can include one or more content objects and one or more administrative objects for registering the content object(s) in an end user's object registry and/or for providing mechanisms for enforcing permissions and/or other security functions. Contained administrative object(s) may be used to install necessary permission records and/or budget information in the end user's electronic appliance.

Content Objects

Figure 20 shows an example of a VDE content object structure 880. Generally, content objects 880 include or provide information content. This "content" may be any sort of electronic



TRAVELING OBJECT

FIG. 19

A Capsulated Content Providing Services Adaptable for User's Requests

3.2 Description of Ticket Method

In a capsulated content, component data stored in each gate keeper is symmetrically encrypted by a key exclusive for the component data. Blocks of component data are denoted by D_1, D_2, ... D_n, and keys for the blocks of data are denoted by K_1, K_2, ... K_n. Then, the encrypted component data stored in the respective gate keepers can be expressed by as follows:

$$ED_1 = \{D_1\}^{K1}$$

$$ED_2 = \{D_2\}^{K2}$$

...

$$Ed_n = \{D_n\}^{Kn}$$

At this time, from a key K_i, a value TK_i^{UK} is calculated. "UK" is a value corresponding to one particular service with regard to one particular block of component data, and this is called a use key.

$$Tk_i = \{K_i\}^{UK}$$

$$UK = \text{hash (spec}(ED_i, \text{ service}))$$

The spec(ED_i, service) is expressed as "name of a content/author/content data ID/service ID".

The encrypted component data ED_i is enclosed in the capsule, and the data ED_i and the ticket key for a particular service TK_i^{UK} are recorded in an ACL and controlled by a ticket server. In the MediaShell, the ticket server functions as a

reliable third party.

Next, decryption of the encrypted component data is described. As mentioned above, at an arbitrary time, a user requests for a service with regard to a component data, and the user gets a ticket corresponding to the service. Thereafter, decryption and output of the component data are performed. This procedure can be expressed as follows:

(1) $UK = \text{hash}(\text{spec}(ED_i, \text{service}))$

(2) $K_i = \{TK_i^{UK}\}^{UK}$

(3) $D_i = \{ED_i\}^{Ki}$

In this method, thus, different ticket keys are generated for different services with regard to each component data, and the ticket, in which the ticket key is recorded, is delivered. If a decryption key is recorded in the ticket, it would be easy for other users to get the component data illegally by taking out the decryption key. In this method, however, since the decryption key is not recorded in the ticket, the component data is secured from such illegalities. The security will be discussed in the paragraph 5-1.

5.1 Security

Users' and authors' advantages which are obtained from the use of tickets and IC cards have been described above. Now, security from illegal usage of digital contents is discussed.

In distribution of capsulated digital contents, by use of tickets, there are possibly various kinds of illegalities. However, these illegalities can be generally classified as follows:

1. analysis of encrypted component data by a user or a third party

2. steal of a ticket by a third party

3. illegal use of a ticket for other services by a user

4. illegal delivery of a ticket from a user to a third party

Digital contents are secured from illegalities of the first kind by encrypting the component data by use of Blowfish which is of a key length of 128 bits. The encryption of this level is very safe, and according to the estimation shown in the document [7] (B. Schneier, Applied Cryptography 2nf Ed., Wiley, 1996), if an attacker hardware which can decrypt DES for average 2 minutes is used, it would take 10^{16} years to decrypt the encrypted component data.

With regard to illegalities of the second kind, as already described in the chapter 3, the tickets are encrypted by use of an open key for users. Therefore, even if a third party steals a ticket, the third party cannot use the ticket unless he/she has a private key for a user.

With regard to illegalities of the third kind, since the ticket keys are not decryption keys, it would be difficult for an ordinary user to use a ticket key for other services. However, a sufficiently skillful user may be able to trace the operation of gate keepers and/or may imitate the method described in the chapter 3. By adopting an obfuscation technique which confuses data flows, it would be more difficult to trace the data flows. Also, illegal decryption of decryption keys will be able to be prevented by

heightening the level of generation of the use keys.

At last, with regard to illegalities of the fourth kind, since the ticket delivered to each user is encrypted by use of an open key, when the user delivers the ticket to a third party, the user must do either one of the following things: (1) attaching the user's private key; and (2) decrypting the ticket and again encrypting the ticket by use of the third party's open key. The illegality (1) is technically easy to commit. However, revealing the user's own private key, which is an identification on a network, is unrealistic. The illegality (2) requires a certain extent of skill. However, the illegality (2) is psychologically easy to commit. At present, it is impossible to prevent these illegalities. However, by storing private keys in an IC card and by setting rights to access the private keys properly, it will be more difficult to commit these illegalities. Also, since a ticket is effective to only one block of component data, even if a ticket is delivered illegally, the damage will be only one photograph or so, and the economical damage will be minimum. This is also an advantage of a MediaShell capsulated content.

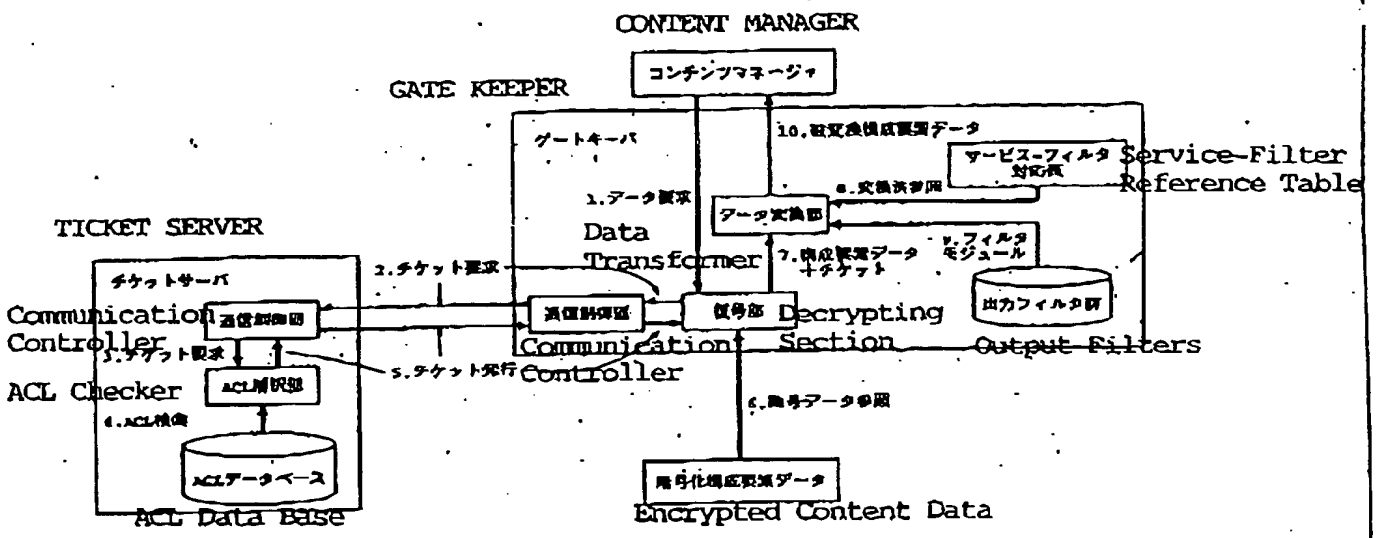


図4: ゲートキーパおよびチケットサーバの内部構成

Fig. 4; Internal Structures of Gate Keeper and Ticket Server

1. Request for Data
2. Request for a Ticket
3. Request for a Ticket
4. Search in ACL
5. Issue of a Ticket
6. Reference to Encrypted Data
7. Content Data + Ticket
8. Transformation Method
9. Filter Module
10. Transformed Content Data

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